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U. S. Department of Agriculture
Forest Service

CENTRAL STATES FOREST EXPERIMENT STATION

168 - 14th Avenue, Columbus, Ohio

ANNUAL INVESTIGATIVE REPORT FOR 1935

AND PROGRAM FOR 1936

(Calendar Years)

CENTRAL STATES REGION

Ohio
Indiana
Illinois
Iowa
Missouri
Western Kentucky
Western Tennessee
Northern Arkansas

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STATION STAFF - 1935

Forest Service

Willis M. Baker	Director
John T. Auten	Silviculturist
Leonard F. Kellogg	Silviculturist
Ralph K. Day	Silviculturist
John G. Kuenzel	Assistant Silviculturist
Boyd B. Parker (a)	Senior Clerk
Berniece Dillon (b)	Senior Clerk
Charlotte Huston	Clerk-Stenographer

Emergency Personnel

Arthur G. Chapman	Associate Conservationist
E. G. Wieseuegel(August - September).....	Associate Conservationist
Oliver D. Diller	Assistant Conservationist
Claud E. Sutton	Technician
Clyde R. Cochran	Assistant Technician
John G. Wood	Senior Clerk
Ben F. Myer	Assistant Statistician
Mary Buzzard	Clerk-Stenographer
Ruth Allen.....(January - May).....	Stenographer
Chas. R. Hopwood	Janitor
E. R. Green	Caretaker, Sylamore Branch

Cooperating Personnel

E. R. Warner	Technical Foreman, C.C.C. (Illinois)
W. O. Stephens	Inspector, C.C.C.

Bureau of Entomology

Ralph C. Hall, in Charge	Assistant Entomologist
W. H. Cummings.....(Appointed October 1).....	Junior Entomologist
Harold A. Waters	Junior Entomologist
Charles R. Page	Scientific Aid
Herbert C. Secrest ..(Resigned September 23)...	Scientific Aid

(a) Transferred to Region 3 on August 1, 1935.

(b) Transferred from Washington, D. C. on September 15, 1935.

FOREWORD

The Central States Forest Experiment Station is one of twelve regional stations maintained by the Branch of Research of the Forest Service, U. S. Department of Agriculture. Created by act of Congress, the Station was established at Columbus in 1927, in cooperation with the Ohio State University and the Ohio Agricultural Experiment Station. Studies and investigations are conducted by the Station to secure essential information concerning the forest problems of the central hardwood region. The territory served includes all or part of eight states: Ohio, Indiana, Illinois, Iowa, Missouri, western Kentucky, western Tennessee, and northern Arkansas. Representatives of various interests in this region constitute the membership of the Central States Forest Research Council, which acts in an advisory capacity to the Station, and as a coordinating agency for forest research.

CENTRAL STATES FOREST RESEARCH COUNCIL

1935

Alexander Thomson, President, C. V. Anderson, Vice-Pres., W. M. Baker, Sec.
C. Vivian Anderson, Insurance, 1205 Union Trust Building, Cincinnati, Ohio.
C. H. Barnaby, Lumberman, Greencastle, Indiana.
R. M. Brown, President, Missouri Farm Bureau, Jefferson City, Missouri.
T. H. Frison, Chief, State Natural History Survey, Urbana, Illinois.
Chas. A. Gillett, State Forester, Little Rock, Arkansas.
J. O. Hazard, State Forester, Nashville, Tennessee.
Chas. E. Hearst, President, Iowa Farm Bureau, Des Moines, Iowa.
C. F. Huhlein, 615 Louisville Trust Co. Bldg., Louisville, Ky.
S. B. Locke, Conservation Director, Izaak Walton League, Chicago, Ill.
Geo. B. MacDonald, Professor of Forestry, Iowa State College, Ames, Iowa.
Lachlan Macleay, Exec. Vice-Pres., Mississippi Valley Asso., St. Louis, Mo.
A. F. Moon, President, Ohio Conservation Council, Columbus, Ohio.
E. E. Pershall, President, T. J. Moss Tie Co., St. Louis, Missouri.
Edmund Secrest, State Forester, Wooster, Ohio.
J. H. Skinner, Director, Purdue Agri. Exper. Station, Lafayette, Indiana.
Earl C. Smith, President, Ill. Agri. Asso., 608 Dearborn St., Chicago, Ill.
Alexander Thomson, President, Champion Coated Paper Co., Hamilton, Ohio.
E. N. Transeau, Professor of Botany, Ohio State University, Columbus, Ohio.
Tom L. Wheeler, Editor, Indiana Farmers Guide, Huntington, Indiana.
Ralph Wilcox, State Forester, Indianapolis, Indiana.

Forestry Continues on an Emergency Basis

During 1935 forestry in the Central States has maintained much of its recent advancement chiefly through emergency allotments of federal funds to combat the critical problems of unemployment and the misuse of lands. Contributing in a large measure to recent progress have been the acquisition of National Forest lands in all the states of this region, and the continuation of the Civilian Conservation Corps. Through the passage of the Fulmer Bill by Congress, the way has been opened for increased acquisition of public forest lands by the states. A wide-spread effort is being made to bring about conservative management and continuous timber production in privately owned woodlands, particularly in the farmwoods. Tree nurseries for the production of forest planting stock have been expanded in size and increased in numbers to meet the demands of the extensive reforestation program now under way. Opportunities and obligations for the practice of intensive forestry on a large scale are developing rapidly in the Central Hardwood region.

To those who realize how greatly our national welfare depends upon forest restoration and conservation, it is decidedly disturbing to reflect that so much of the recent progress in forestry is dependent upon emergency funds and temporary organization. In the difficult times through which we have passed no other approach may have been possible, but the public interest certainly requires that this emergency forest program be placed upon a sound, permanent, adequately financed basis at the earliest opportunity, with definite obligations logically coordinated between responsible public agencies.

Many persons have known nothing of forestry until the recent emergency brought it to their attention, and naturally they now classify forestry along with other temporary activities. They should be informed of the record for sound public policy and progressive development earned by the U. S. Forest Service and by many State forestry departments during the past thirty years.

Lack of Essential Information Threatens Progress

It is equally disturbing to know that, during this emergency expansion of forestry, little provision has been made for studies or investigations to provide the knowledge essential to the success of the projects being undertaken. The Central Hardwood region is notoriously lacking in information necessary for profitable woodland management, for successful reforestation, or for an understanding of forest influences upon soil, water or climate. Because of the failure to provide for research on a scale required by other lines of work undertaken, and in advance of forest acquisition or attempts at management, a critical situation is rapidly developing. Forestry should not be subjected to the possibility of unfavorable public reaction resulting from glaring mistakes or costly delays, which are inevitable unless projects are based upon knowledge and established facts. Those in charge of various phases of the work and responsible for its success should recognize this, and should insist that an adequate program of forest research be initiated immediately on a sound, permanent basis.

STATION ADMINISTRATION

Headquarters. On September 10 the Station moved its headquarters from the Horticulture and Forestry Building of Ohio State University, which it had occupied for eight years, to a leased building at 168 - 14th Avenue, one block east of the Campus. Crowded conditions following steadily increasing student enrollment at the University made this move necessary. In other respects Ohio State is expected to continue its cooperation with the Station. The new quarters, the best which could be secured at this time in the vicinity of the University, provide increased office space and facilities for work, but they are already used to capacity and are inadequate in many respects for the use of an experiment station. W. O. Stephens, E.C.W. inspector for State C.C.C. camps in Ohio and Indiana, continues to make the Station his headquarters office.

Personnel. There has been only one change in the regular personnel of the Station during 1935. In August it was necessary for Senior Clerk Boyd B. Parker to accept a transfer to Albuquerque, New Mexico, because of ill health in his family. The vacancy was filled by the transfer of Berniece Dillon from the Washington office of the Forest Service on September 15. The increased clerical work of the Station has been taken care of by the emergency employment of John G. Wood since January, 1935. Several changes have been made in the technical force of the Bureau of Entomology as indicated in the list of personnel found on page 3.

Equipment. Funds have not been available for the purchase of much new equipment during 1935. Two new International half-ton trucks were purchased for the use of E.R.A. crews on the experimental forests, and a worn-out Chevrolet delivery sedan was turned in. Other new equipment purchased included a Clipper seed cleaner and a Roover's embossing machine for numbering metal tree tags. Three confiscated passenger automobiles in fair condition were transferred to the Station by the Bureau of Narcotics, and the Veterans' Hospital at Marion, Indiana turned over a considerable quantity of furniture suitable for use at branch stations.

Miscellaneous Activities. Members of the Station staff cooperated with administrative officers of the Forest Service, particularly in Ohio and Illinois, in formulating plans for timber stand improvement work, in locating and developing forest nurseries, and in other ways. The director attended Forest Service staff meetings in Washington in April and November. Kellogg spent several weeks preparing a preliminary natural vegetation map of the Central States region. Day served as secretary and Baker as chairman of the Central States Section of the Society of American Foresters; Auten continued as chairman of the forest soils committee of the American Soil Association. A number of meetings and conferences were attended by various members of the staff, and upon fifteen occasions talks were given or papers read. Sixteen publications were prepared and distributed by the Station during 1935; several others are now in press or ready for publication. These are listed on the last page of this report.

Finances. During the fiscal year 62 per cent of the Station's funds have been allotted from temporary emergency appropriations, and 45 per cent of the total have been E.R.A. funds for unemployment relief. These have been available chiefly for the employment of local labor, with only a small proportion usable for technical services or supervision, materials, equipment, and overhead expenses. Under the circumstances the use of these funds for actual research projects appeared impractical. Consequently, they have been devoted chiefly to the further development of experimental areas and branch station improvements in Arkansas, Illinois, and Ohio.

Branch Stations and Experimental Forests

Illinois. In May, 1935, a 25-man C.C.C. crew with a technical foreman (E. R. Warner) in charge, was assigned to the Station by the National Forest Supervisor for work on the southern Illinois experimental forest area, the development of which was begun with emergency funds in 1934. Since only a portion of the land within this proposed area has been optioned for National Forest purchase, and since a still smaller acreage has actually been acquired to date, the kinds of work which could be attempted with the C.C.C. crew have necessarily been very limited. So far the time has been divided between the establishment of plots for research studies described elsewhere in this report, and the development of improvements at the branch station headquarters. In July the latter project was enlarged by an allotment of E.R.A. funds to provide a year's work for 10 unemployed local residents. Working under the direction of Claud E. Sutton, the improvement crews have accomplished considerable landscaping at the headquarters site. Flagstone walks between buildings, stone steps, and masonry retaining walls, all constructed with stone quarried locally, have added greatly to the appearance and the permanent stability of the headquarters. Fire-breaks have been cleaned out around the buildings and elsewhere on optioned lands within the proposed boundaries of the experimental area. Large quantities of wooden stakes and posts have been cut and stored for future use in marking plots. Funds have not been available for the construction of the several buildings and other improvements needed to complete this branch station development. Ralph K. Day has supervised the work on this area as well as that on the Sylamore Experimental Forest in northern Arkansas.

Arkansas. An allotment of E.R.A. funds for the Station's use in Arkansas permitted the start of a similar development project on the Sylamore Experimental Forest early in August. For the first two months the 10-man crew worked under the supervision of E. G. Wieseuegel, professor of forestry at Ohio State, who was given a temporary appointment during the summer period. A number of improvements were made to the buildings, roads, and grounds at the branch station headquarters. In October, O. D. Diller was transferred to take charge of the work, and under his direction several miles of truck trails, valuable both for protection and transportation, have been constructed through hitherto inaccessible portions of the area. A large quantity of plot stakes and posts have been cut from material salvaged in clearing right-of-way. Additional acquisition of National Forest lands adjacent to the northwest corner of the Experimental Forest has made it advisable to extend the west boundary due north to its intersection with the Bearhead motorway, thereby adding considerable acreage and simplifying administration. Another boundary adjustment is being made along the south line to include the building site and the water development south of the Green motorway.

Ohio. In the spring of 1935 the National Forest Purchase Units in southern Ohio were examined by Kellogg and Baker for the purpose of locating an area suitable for development as an experimental forest. A very satisfactory location was finally found on the McArthur Purchase Unit in Vinton County, near the old Richland Furnace. In July an allotment of E.R.A. funds made it possible to start work on the area with a 10-man crew, but the kinds of projects that could be attempted have been decidedly limited by the delay in purchasing or optioning lands in this vicinity. Under the direction of Clyde R. Cochran a general reconnaissance of the proposed area has been made; a topographic control survey has been started; an intensive soil survey has been made on three sections; quantities of native tree seeds of various species have been collected; chestnut plot stakes, posts and poles have been cut for future use on the area, and field preparations have been made for experimental plantations. Kellogg has given general supervision to the work on this area, while Auten has directed the soil survey. No branch station improvements have been started because of lack of funds for this purpose, and also because of the delay in acquiring an administrative site.

Plans for 1936. It is expected that the emergency funds for improving the experimental areas on National Forest lands in Ohio, Illinois and Arkansas will be available until July, 1936, permitting the continuation of improvement projects now under way. Beyond that date no plans can be made at the present time. The two field headquarters buildings constructed for the use of the Station on the Morgan-Monroe State Forest in Indiana and on the Shawnee State Forest in Ohio, respectively, are completed and ready for occupancy, but the Station has had no funds with which to develop these cooperative experimental areas or to initiate new research projects there. The federal areas now under development in Arkansas, Illinois, and Ohio require more buildings and other improvements as funds are made available, and a similar experimental forest should be established in Missouri at the earliest possible time.

RESEARCH PROJECTS

FOREST PLANTING

Leonard F. Kellogg, In Charge

Reforestation Survey. Field observations of all forest plantations that could be found in the rough hill-lands of the Central States south of the Corn Belt, made by Chapman in 1934, were followed by an inspection of the forest nurseries of the region in 1935, to determine their important problems. One result of this work has been a better understanding of the research studies required to meet the situation brought about recently by the great increase in reforestation. Reports of the findings of these surveys have been prepared and distributed to various interested organizations; articles summarizing the outstanding facts are now being prepared for publication.

Experimental Planting. Approximately twelve acres of experimental plantations were set out by Kellogg and Chapman in March. On the Sylamore Experimental Forest in northern Arkansas four acres of chert-covered abandoned fields were planted with excellent stock of shortleaf pine, with tests of scalping and mulching checked by no preparation of the site. A severe August drought, following relatively wet spring and early summer seasons, caused considerable mortality, even on the mulched plot. On the experimental area in southern Illinois about eight acres of old fields were planted with shortleaf and pitch pines, black locust and yellow poplar. Plots were prepared by plowing and with contour furrows, with check plots given no treatment. Tests of fertilization and mulching were made on the yellow poplar plots. Late in the fall Kuenzel added another series of plots on a severely eroding slope to determine the establishment of hardwoods and pine, by planting seedlings and seeds on bare areas and on sites protected with a heavy hardwood leaf mulch.

Nursery Work. During 1935 the Station was able to start a limited amount of nursery work. Seed beds of black locust and shortleaf pine (Ohio seed) were made on Ohio State University lands at Columbus, and at the Forest Service Nursery at Junction, Illinois. Small quantities of other hardwoods were also grown at Columbus, and tests were made of locust seeds which had been scarified or treated with acid. Good hardwood stock was produced in the Columbus seed beds, but complete failure of the shortleaf pine was caused by damping-off resulting from a combination of heavy soil and a wet season. The results secured at the Junction nursery were generally unsatisfactory.

Black Locust Seed Treatment. Timely work by Chapman on black locust seed treatment has demonstrated the value of scarification in increasing and hastening germination. After considerable work he succeeded in altering an "Ames" type machine so that optimum scarification was secured rapidly and with very little loss of seed through breakage. Tests of scarified seed showed prompt and very complete germination. The results of this work

have been published as Station Note No. 26, and in an article appearing in the January (1936) issue of the Journal of Forestry. With the modified machine quantities of locust seed were scarified for the Forest Service in Illinois, and for the Soil Conservation Service in Ohio and in Iowa.

Different lots of locust seed were found to vary widely (from 11% to 89%) in the permeability of the seed coats to water. Efforts to determine the causes of this, and the anatomical structure concerned with impermeability, have yielded data that will be published at an early date.

Seed Collection. During the fall season the Station's E.R.A. crews in Ohio and Illinois collected considerable quantities of seed of black locust, yellow poplar, and shortleaf, pitch, and Virginia pine, as well as smaller amounts of other hardwood species. In general it was not a good seed year, but supplies of most species were secured for seed studies and for future use in planting. The work of drying, extracting, cleaning, and recording seed data was carried on by Myer at the Station headquarters in Columbus under Kellogg's direction.

Plans for 1936. Uncertainty as to the duration of the Station's emergency funds makes it impossible to formulate definite plans for 1936 at this time. With the continuation of present allotments it may be possible to carry on a limited amount of experimental planting and nursery investigations, and to publish in periodicals or in mimeograph form some of the results of past work. Kellogg is taking advantage of every opportunity to continue the preparation of his manuscript on planted black walnut. However, if the Station is to engage in comprehensive studies required by the magnitude of the reforestation job in the Central Hardwood region, more funds must be made available.

FOREST MANAGEMENT

Ralph K. Day, In Charge

Farm Woods

Recovery After Grazing. This project, carried on in Indiana since 1930 in cooperation with the Purdue Agricultural Experiment Station, was continued in 1935. During the summer the annual remeasurements of the regeneration plots (in woodlands from which livestock had been removed) were completed by Diller with the help of a field assistant employed by Purdue. The first five-year remeasurements of the growth and yield plots in farm woods were also made, and repeat photographs were taken where significant changes had occurred. Because of the necessity of transferring Diller to Arkansas in September, to take charge of the E.R.A. project at the Sylamore Experimental Forest, there has been no opportunity to analyze the 1935 data. The livestock grazing phase of the carrying capacity study at the Pinney-Purdue Farm near Wanatah was completed in 1934.

Diller contributed two mimeographed reports during the year dealing with phases of his farm woods studies. Station Note No. 24 discussed the effect of woodland grazing on certain site factors, emphasizing the adverse

conditions of moisture and temperature which influence the regeneration of tree species. Station Note No. 25 dealt with the control of sprouting of hop hornbeam by cutting low stumps. A third article, printed in the January (1935) issue of Ecology, considers the relationship of temperature and precipitation to the growth of beech in northern Indiana.

Dubois County Sustained Yield Project. Work on this cooperative project was started late in 1934 by the Regional Office of the Forest Service, the Purdue Agricultural Experiment Station, the Indiana Division of Forestry, and the Central States Station. Preliminary field work was concluded during 1935, and a mimeographed report to which Day and Kuenzel contributed has been prepared in the Milwaukee office of the Forest Service. This report summarizes the field data collected and proposes the establishment of cooperative marketing of forest products, intensive education and demonstration in proper woodland management and utilization, and the development and initiation of individual working plans which will be so correlated as to assure a continuous source of raw material for the industries and ultimately sustained yield. An assistant State extension forester has been added to the staff of the Purdue Agricultural Experiment Station to head this project.

Day, Kuenzel, and Diller spent several months' time collecting and assembling data for the preliminary report. Local volume tables, which were based on differences due to site, were prepared for all the important species in each forest type. Increment borings were taken for the growth and yield tables made for each forest type in the county, using a composite table similar to Schumacher's tables for determination of a regulation of the cut. Stand and stock tables for the several forest types encountered, and increment tables, were prepared. A comparison of the growth rates in Dubois County with those obtained in Clark County for similar forest types showed the Clark County rate of growth to be considerably lower. Dubois County diameter-height curves for all-aged stands compared very favorably with similar data obtained from a woodland in Marshall County in northern Indiana. Additional time was spent by Kuenzel collecting field data for determining the amount of defect and cull per cent for the species encountered in the forest survey. Data assembled from woods operations, portable mill operations, and other measurements were compiled to provide cull per cent tables for important species in each forest type.

This project has been undertaken on a cooperative basis by four organizations, each of which contributed time, personnel, and funds from already overburdened programs and overtaxed budgets. Circumstances made it necessary to conclude field work rather hastily, and to prepare the preliminary report in the same manner. Much of the data are admittedly extensive and preliminary in character. One of the first objectives of the project as continued should be to gather additional economic and silvicultural data, and to perfect the tentative plans and supporting tables set forth in the report.

Upland Forest Management

Southern Illinois. The management studies in extensive upland forest areas during the present year have been confined almost entirely to the southern Illinois experimental forest where it has been possible, through the help of a 25-man detail from the Hicks C.C.C. Camp, to carry on

considerable investigative work and plot establishment which would not otherwise have been possible because of the limited funds available in the regular allotment of the Station.

A number of permanent growth plots have been established by Kuenzel and Warner in the excellent all-aged stand adjacent to the headquarters site. Three half-acre plots have also been established to demonstrate selection cutting in this tract. On one of these plots the mature stand will be largely removed with the object of affording sufficient light for regeneration. On the second, inferior species and other undesirable trees will be removed from the understory on the theory that this may provide sufficient light for regeneration, and retention of the mature stand may insure reproduction of the heavier seeded species, the overhead stand to be removed after reproduction is established. The third plot will be retained as a check.

Several series of plots, 0.1 acre in size, have been established to determine the advance of natural reproduction of various hardwood species into abandoned, worn-out and eroding old fields. Parallel to one of these series, a second series has been established to determine what effect a leaf litter mulch may have on the advance of reproduction, also on erosion and on planted seedlings.

Another management study in the mixed upland hardwood forest typical of southern Illinois was initiated on the Fowler tract of the experimental forest during 1935. The unusual distribution of types between ridges and stream bottoms made it advisable to lay out a series of replication plots along a strip extending across the topography. Ten such plots were surveyed and the trees chosen as crop trees were tagged and marked. In each instance an adjacent check area of equal size was marked in similar fashion. As the optioned land is made available to the Station, the plots will be treated by cutting to improve the growing conditions for the crop trees. Growth of these trees will be compared with that of the marked trees on the adjacent check plots.

Southern Indiana. The study of chestnut oak reproduction under various degrees of cutting in the overhead stand, started in 1929 on the Clark County State Forest in southern Indiana, has yielded some interesting information described by Kuenzel in Station Note No. 23. He points out the difficulties of securing good growth of seedling reproduction in competition with sprouts, and especially under partial shade. The future value of the Station's selection cutting plots on the Mill Tract area, remeasured in 1934, has been greatly reduced by the construction of a small lake and recreational developments on a portion of the area.

Plans for 1936. As in the case of other projects, it is now impossible to make definite plans for the Station's management studies during 1936. With the resources now available it will be possible to continue the annual re-measurement of regeneration plots established in farm woods, and to carry on the few projects now under way on recently established experimental forests. Without additional funds, however, it will be impossible to start the many studies of regeneration, stand improvement, protection, and management that are now so urgently needed within the Central Hardwood region.

FOREST SOILS

John T. Auten, In Charge

Plantation Sites. Auten's manuscript dealing with the results of two seasons' soil profile study of black locust and black walnut plantations in the Central States has been completed and submitted for publication. The investigation clearly indicates the great importance of the soil profile, the structure of the various horizons, and especially the development of a tight subsoil, in influencing growth of locust and walnut. Good drainage and aeration as indicated by color of the subsoil were distinctly correlated with tree growth.

In 1935 a soil profile study was made in a 17-year-old yellow poplar plantation in Athens County, Ohio, in an attempt to determine the great variation in tree growth that occurred within an area of one acre. The plantation occupied a sheltered location on a lower slope where the soil was largely residual material derived from sandstone and shale. The topography of the entire area was the same, and from casual observation, no differences in the color, texture, or condition of the surface soil were apparent. It appeared to be a good site for yellow poplar. In one part of the plantation the trees had made excellent growth, the largest being 45 feet tall and 8 inches in diameter, whereas a short distance away no tree exceeded 8 feet in height or 2 inches in diameter. A study of soil profiles showed a tight plastic subsoil beneath a shallow surface horizon in the area of poor growth, and a loose, porous structure in the area of good growth. The results of this study were published in an illustrated article printed in the October (1935) issue of the Journal of Forestry.

It had been planned to extend this study of plantation sites throughout the region in 1935, to determine as far as possible, from established plantations and natural stands showing both good and poor growth, the site requirements of various tree species used for reforestation. Such information is urgently needed to help prevent mistakes in the recently expanded planting program of the Central States. However, this needed work had to be postponed because of lack of funds.

Forest Sites. A comparative study of soil and site conditions on adjacent areas of different forest cover types was started by Auten and Kellogg on the Richland experimental area in Vinton County, Ohio. The study area contained stands of second-growth chestnut oak and of white oak which had never been cleared or cultivated, a 65-year-old stand of short-leaf pine which had seeded in naturally on land cleared and abandoned, and an old, abandoned field. Thus, on adjacent areas of similar original soil conditions were found many of the forest types typical of this region. The study, while not completed, has already yielded some significant information.

It was found that the water-absorbing capacity of the pine site exceeded slightly that of the chestnut oak and white oak soils, and was 700 per cent greater than that of the adjacent old field. The increase in pore space of the shortleaf pine soil was only 6 per cent greater than that of the old field, indicating that a very slight increase in soil porosity makes possible a very great increase in the rate of water absorption. The pine site had accumulated on its surface almost 15 tons of combustible organic matter per acre, an amount considerably greater than was found on either of the oak sites, but there were no significant differences in the amount of total nitrogen in the soils of the different areas, including the abandoned field. Apparently there was very little nitrogen fixation in this soil. Kellogg has cooperated in this project with assistance in plot establishment, and in computing the volume growth and yield of each.

Soil Survey. A soil survey of the Richland experimental area in Vinton County, Ohio, was started in the fall by four men of Cochran's E.R.A. crew working under Auten's supervision. The area was covered by strips 5 chains apart, on which observations and measurements of cover and soil were made at one-chain intervals. Maps on a scale of 16 inches to the mile have been completed for three sections. They show the character of the cover type; the depth of litter, leafmold, A₁ horizon, total A horizon, and depth to shale or sandstone; the area having 40 per cent or more of surface rock; and the area underlain with white clay subsoil.

Miscellaneous. Auten has made a start, when opportunity offered, of abstracting forest soil literature, with the object of compiling in convenient form basic references valuable to forest soil workers. Some time was spent attempting to devise an amplifying circuit in connection with a glass electrode and potentiometric set-up, rugged enough to be transported for field use. His results were only slightly successful, but such an outfit has recently been perfected elsewhere and is now on the market. A popular article entitled "The Wooded Earth" has been accepted for publication by American Forests.

Plans for 1936. If additional funds are made available, the site requirement study of reforestation species will be continued in 1936. This work is urgently needed. Otherwise, it will be possible to carry on only the projects now under way on the Richland experimental area in Ohio. No definite planning is possible at this time.

FOREST INSECT INVESTIGATIONS

Bureau of Entomology and Plant Quarantine

Ralph C. Hall, In Charge

The Locust Borer

Accelerating Locust Growth. The results of previous work on the locust borer problem have indicated very close relationship between tree vigor and borer injury. For this reason a major part of the work of 1935 has been devoted to tests of methods which gave promise of accelerating growth in black locust. Mulching experiments, in which locust plots were covered with hardwood leaves to a depth of about six inches, have given results indicating increased growth in height and diameter. Apparently mulching improves the soil moisture conditions of the site, which suggests the desirability of growing locust in mixture with other hardwoods. Preliminary experiments of fertilizing black locust stands with a complete commercial fertilizer were initiated in the spring of 1935. At this time no marked differences can be noticed between the treated and untreated plots.

Cutting black locust to induce vigorous sprout growth appears to offer very definite promise as a means of controlling the locust borer in slowly growing stands. Experiments have been under way on this phase of the problem for three years and data are rapidly being accumulated on the growth to be expected from such treatment. In general, it appears that height growth ranging from 6 to 15 feet may be expected during the first year. Evidence exists that sprouts from slowly growing stands seven years of age may exceed in one year the height previously attained by the parent tree. Experiments were started in 1935 to determine the proper time of cutting to induce maximum growth of sprouts, but it will be several years before this study can produce significant results. From the preliminary work it appears that black locust will sprout from the stumps regardless of the time of year that it is cut. Tests of girdling to stimulate sprout growth have not yet given promising results. Pruning experiments were also begun this year to determine the proper time and methods to prevent the development of water sprouts.

Larvae Survival. Additional evidence has been secured to demonstrate the relationship between tree vigor and mortality of borer larvae. This year's observations showed a very high survival of larvae on slow growing trees in comparison with those that were growing rapidly. The technique of collecting locust borer eggs in large quantities was improved so that more than 10,000 were secured. This made possible the infestation of over 100 trees for larvae survival studies, the data from which should contribute more complete information on this phase of the problem. Further data were collected on the importance of woodpeckers in controlling the locust borer. This year about 50 per cent of all the larvae on the Cambridge plots were removed by woodpeckers, and it appears that these birds may be very important in controlling the borer in certain areas.

Desirable Varieties of Black Locust. Active cooperation has been given to the Soil Conservation Service in their study of ship mast locust on Long Island. This very desirable variety is being widely propagated by the Soil Conservation Service for use in their future planting program. The Division of Forest Insects has contributed a considerable amount of time to the testing of this variety for resistance to locust borer injury on a number of planting areas in the Central States. Additional work is being done with a very desirable straight-stemmed variety of black locust in Indiana, which appears to offer as much promise as ship mast, and seems to be relatively immune to locust borer injury.

Nursery and Plantation Inspection

An inspection covering most important forestry nurseries in the states of Tennessee, Kentucky, Mississippi, Missouri, Arkansas, Iowa, Illinois, Indiana, and Ohio was made with A. G. Chapman during the early fall. During this trip 20 nurseries were visited as well as numerous conifer plantations. The insect problems as a whole in these nurseries were not serious, but many have indications of developing into real problems unless control measures are instituted. The white grub, lesser corn ear worm, wire worms, and Nantucket pine tip moth were among the more important species, but defoliators, cut worms, leaf hoppers, and termites were of some importance locally.

Nantucket Pine Tip Moth. A survey of the tip moth injury to plantations and nurseries in the Central States indicates that it is a serious pest on hard pines in the southwestern part of the region. Considerable damage was observed in many of the shortleaf and loblolly pine plantations in Tennessee, western Kentucky, northern Mississippi, and southern Illinois. Ample evidence exists that practically all the stock in these plantations was infested by the egg stage of the insect while still in the nursery, with the result that no larval parasites were introduced with the host. This assumption was borne out by rearing experiments in various plantations. The average percentage of parasitism in plantations from infested nursery stock was less than five, in contrast to more than fifty per cent in plantations infested from local pine stands. From evidence at hand it would appear that parasites may prove to be a very valuable aid in controlling the tip moth. To prevent infestation in future planting, nursery stock should be treated in the spring to destroy any eggs which may be present, and at the same time all infested tips should be removed and destroyed. Active cooperation with various agencies in the treatment of nursery stock is now planned for the spring of 1936.

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Day, Ralph K., and Kuenzel, J. G. (Co-authors with others) Continuous forest crops from Dubois County farm woods.